

exclude the low promontories and ranges of hills around the great mass, since the vegetation of these, both geologically and botanically, agrees with those of the terraces of the Elbe and the Weser. The uniformity of structure of the great central mass of the Hartz, the rarity of lime, &c., causes a comparative poverty of peculiar forms of flowering plants, but, on the other hand, a subalpine character may be detected, and this at a height above the sea which would not lead one to expect it. Another feature, long ago pointed out, is the depression of the climatic tree-limit. Dr. Drude gives the following list of the twenty-four rarer or characteristic species of the Brocken flora:—*Listera cordata*, *Epipogon aphyllus*, *Trichophorum caespitosum*, *T. alpinum*, *Carex pauciflora*, ? *C. Heleonastes*, *C. rigida*, *C. limosa*, *C. sparsiflora*, *Geum montanum*, *Linnaea borealis*, *Hieracium alpinum*, *H. nigrescens bructerum*, *Andromeda poliflora*, ? *Pinguicula alpina*, *Pulsatilla alpina*, *Empetrum nigrum*, *Rumex arifolius*, *Thesium alpinum*, *Salix bicolor*, *Betula nana*, *Lycopodium alpinum*, *Selaginella spinulosa*, and *Athyrium alpestre*.

*Saxifraga Hirculus* was found by Kohl in the neighbourhood of Zorge in 1809, but does not seem to have been gathered by anyone since that date, and many other interesting notes on individual species are given.

Hampe, in his "Flora Hercynica," gives 1343 vascular plants as occurring within his area, and there is a good deal of additional information on the distribution of plants in this region in A. Andree's little pamphlet "Die Flora des Hartzes und des Östlichen Vorlandes bis zur Saale."

The Erzgebirge, a chain of mountains mostly of primary formation, are on the south-east of the area taken by Dr. Drude. A long list of the characteristic species is given, from which we select the following as particularly worthy of note:—*Orchis globosa*, *Herminium Monorchis*, *Coeloglossum viride*, *Gymnadenia albida*, *Listera cordata*, *Corallorrhiza innata*, *Lilium bulbiferum*, *Streptopus amplexifolius*, *Polygonatum verticillatum*, *Luzula sylvatica*, *L. sudetica*, *Trichophorum caespitosum*, *Carex pauciflora*, *C. rigida*, *C. supina*, *C. limosa*, *Calamagrostis montana*, *Poa sudetica*, *Scheuchzeria palustris*, &c.

*Meum athamanticum*, *Orchis globosa*, *Gentiana spathulata*, and *Phyteuma orbiculare*, which are present in the Erzgebirge, are wanting in the Upper Böhmer Wald, and only the Meum and the Phyteuma reach the Hartz. *Senecio crispatus*, in the Thuringen Wald, reaches its northern limit in Hercynia, but it is impossible in a brief notice to give any idea of the mass of detailed information which Dr. Drude has here collected together.

Much good work has recently been published on the distribution of plants in various portions of the globe. In Central Europe there have been the preceding volumes in the present series, Prof. Moritz Willkomm's "Iberian Peninsula," Dr. Pax's admirable work on the Carpathians, Dr. Gustav Radde on the Caucasus, Dr. Beck on the various countries included under Illyria, and Dr. P. Graebner on north Germany. In the United States we have had Prof. MacMillan's "Minnesota Plant Life," "The Plant Life of Alabama" by Dr. Möhr, and a report on the Dismal

Swamp region by Mr. Thomas H. Kearney. In this country the late Robert Smith mapped out three districts in Scotland, and his brother, Dr. W. G. Smith, of Leeds, and his colleagues have already mapped out two districts in Yorkshire, and given lists, illustrated by photographs, of the characteristic plants of the different stations. A first instalment of a botanical survey of the basins of the rivers Eden, Tees, Tyne and Wear, by Mr. F. J. Lewis, was lately read at the British Association, and we hope the contemplated survey of the Pennines, from Derbyshire to the Cheviots, will be successfully carried out.

Dr. Drude in Hercynia has done his work most fully and conscientiously. Every possible plant-association connected with every varying physical condition of the country has been carefully noted, and both its phenogamous and cryptogamous constituents have been determined. But we feel that the work may somewhat bewilder the ordinary reader by reason of its excessive elaboration.

E. G. B.

#### MEASUREMENT BY LIGHT WAVES.

*Light Waves and their Uses*. By A. A. Michelson. The Decennial Publications of the University of Chicago. Pp. 166. (Chicago: University Press, 1903.) Price 2 dollars net.

THE University of Chicago, in commemoration of the completion of the first ten years of its existence, is publishing a series of volumes dedicated "to the men and women of our time and country who by wise and generous giving have encouraged the search after truth in all departments of knowledge."

The publication committee is to be congratulated in that it has persuaded Prof. Michelson to contribute a volume to this series. Anything that he writes is sure to be worth careful and attentive study, and while the actual scientific results recorded do not, as a rule, in any way claim to be new, Prof. Michelson has succeeded in putting the important consequences of his own inimitable work in a manner which will render them known to many who could hardly be expected to follow the original papers.

The volume contains eight lectures delivered at the Lowell Institute in 1899. It starts with an elementary account of light waves and their properties, and in the first lecture some of the consequences of the principle of interference are skilfully developed.

But the distinctive tone of the work is not noticeable until we come to Lecture ii., which deals with a comparison of the microscope and telescope with the interferometer.

An account is given of the action of a lens, and the theory of the diffraction fringes formed by a microscope or telescope objective is outlined. This leads to the theory of the resolving power of a microscope, and to the conclusion that, while  $1/250$  of an inch is the limit of resolution for the human eye, that of the microscope is one four-hundredth of this, or about one hundred-thousandth of an inch. It is then shown that by limiting the aperture of a telescope to two parallel slits near the opposite ends of a diameter, the fringes formed become more distinct, though with a considerable loss of light, and from this the action of various

forms of interferometer in which the interfering pencils are separated and then reunited after reflections at a series of plane mirrors is deduced. It is explained, further, that with such instruments the accuracy of measurement possible with a telescope or microscope can be greatly exceeded, and that, too, without serious loss of light.

The application of interference methods to various measurements forms the subject of the remaining lectures.

One of the features of the Edinburgh meeting of the British Association in 1892 was Michelson's paper on the application of interference methods to spectroscopic research read before Section A and printed in full among the reports.

Fizeau had years before explained the gradual disappearance and reappearance of Newton's rings when formed by sodium light between a flat surface and a lens of small curvature as the distance between the two is increased. It is due to the fact that the D line is double; the ring system seen, therefore, is a complex one produced by the superposition of the two systems due to each line separately. When the bright rings of the two systems coincide, the visibility of the rings is a maximum; as the distance between the lens and plate is increased, the bright rings of the first system overlap the dark rings of the second, the intensity of the field becomes uniform, and the rings cease to be visible.

Michelson defined the visibility of the ring system and showed how it depends on the distribution of light in the source; he then proceeded to measure experimentally the visibility of the rings formed by various spectrum lines, and from this to analyse the distribution of light in the lines. By a stroke of genius he utilised the defects of the ring system to advance our knowledge to a surprising extent. Lecture iv. contains a most interesting account of his work.

The chapters that follow are no less fascinating; thus the next lecture describes the measurements undertaken by Michelson at the Bureau International des Poids et Mesures at Sèvres to determine the relation between the wave-length of cadmium light and the standard metre; cadmium light was chosen because of the simplicity of the lines of its spectrum, and it was shown that in air at  $15^{\circ}$  C. and at normal pressure the number of waves in a metre is for the red ray of cadmium 1553163.5, for the green ray 1966249.7, and for the blue 2083372.1. The absolute accuracy of these results is said to be about one part in two millions, the relative accuracy about one part in twenty millions.

In Lecture vii., application of interference methods to astronomy, it is shown how an examination of the visibility curve of a star enables the observer to detect double stars which are far too close to be resolved by any telescope, while the last lecture, on the ether, deals with a problem which is yet unsolved, the theory of aberration.

The aberration constant, the ratio of the velocity of the earth to that of light, is a quantity of the order  $1/10000$ , and its accurate measurement had proved no easy task. Michelson, with the view of solving the question whether the earth is at rest or in motion

relative to the ether at its surface, undertook a measurement which involved the square of this tiny quantity, or one part in one hundred millions, and carried it out successfully. The result of the experiment was to show that this relative motion, if it exists at all, must be extremely small, and that the ordinary explanation of aberration, which assumes that the ether remains at rest while the earth moves through it without disturbing it, is untenable. The only solution of the difficulty yet offered is that due to Lorentz and Fitzgerald, who pointed out, independently, that the notion of a body through the ether might, on certain assumptions as to the connection between ether and matter, cause the body to contract in the direction of motion, and that this contraction would depend on the square of the aberration constant, so that its effect might compensate for the effect looked for by Michelson.

In his first lecture the author apologises for using, as illustrations of his subject, his own researches.

"I do this," he says, "because I believe I shall be much more likely to interest you by telling what I know than by repeating what someone else knows."

Prof. Michelson has earned our thanks for putting some of his knowledge into so attractive a form; he will perhaps forgive us if, in closing, we express the wish that he will tell us more of what he knows.

R. T. G.

#### ALL ABOUT CATS.

*The Book of the Cat.* By Miss F. Simpson. Pp. viii+380; illustrated. (London: Cassell and Co., Ltd., 1903.) Price 15s. net.

THE "cult of the cat" has of late years increased to such an enormous extent that there can be no doubt as to the need for a thoroughly trustworthy and exhaustive account of the various breeds kept in this country, together with notices of those of other lands. Of this favourable opportunity Miss Simpson has taken full advantage in the handsome and beautifully illustrated volume before us, the exceedingly low price of which places it within reach of fanciers in all ranks of life. In addition to the description of the various breeds kept in this country, the author has also given chapters on the feeding, housing, and general treatment of cats (derived from her own extensive experience), as well as on the management of cat-shows; while other chapters by various specialists are devoted to foreign breeds, the cat's place in nature, and the diseases of cats and their treatment. The book is therefore a compendium of all that relates to domesticated cats, and it may be almost said that it contains practically all that is worth knowing about these animals.

Perhaps the least satisfactory portion of the book, so far as Miss Simpson is concerned, is to be found in the opening lines of the first chapter, where we find the statement that the origin of the cat has long puzzled the learned, and is still a zoological mystery. Neither does the second sentence—"Historians tell us that the feline race came into existence about the same